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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 588

Contribution from the Forest Service
HENRY S. GRAVES, Forester

Washington, D. C. November 15, 1917

INCREASED CATTLE PRODUCTION ON SOUTHWESTERN RANGES

By

JAMES T. JARDINE, Inspector of Grazing, and
L. C. HURTT, Grazing Examiner

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BETTER RANGE MANAGEMENT.

This bulletin presents the results of experiments which bear directly on the problem of how to produce more and better cattle on western range lands, a matter of pressing importance in view of the present need for increasing the Nation's food supply.

It is generally conceded that the carrying capacity of the remaining areas of public range is at least 25 per cent less than it was originally, the result of grazing stock at improper seasons and overstocking. It is also a fact that the productiveness of many privately owned ranges, both fenced and unfenced, has been reduced through faulty management. To work out a system of range management and improvement practicable for large grazing units, which will build up the depleted areas and insure the maintenance of the whole range in good condition, is one of the important objects of grazing studies

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made by the Forest Service on the Jornada Range Reserve, a unit comprising some 200,000 acres in southern New Mexico. The problem involves: (*a*) Finding the system of management that will best bring about natural reseeding of the existing forage plants; (*b*) finding new plants suitable for seeding on the ranges of the Southwest; (*c*) determining the number and distribution of stock-watering places necessary for efficient use of the range, taking into account cost of construction and returns expected; and (*d*) determining the carrying capacity of the range as a means of preventing its being overstocked.

Other and related range problems also have been studied on the Jornada Reserve. One of these has to do with improving the average grade of stock and the average calf crop under range conditions, the possibility of which is generally recognized. Another is how to reduce the losses of stock from lack of feed and water in times of drought and from disease and straying that ordinarily occur in the Southwest. Such losses are a big drain on the profits of the stock industry and often retard, or even prevent, the development of desirable breeding herds.

The studies on the Jornada Reserve are by no means completed; when the length of time during which they will be carried on is considered, it might be said that they are hardly begun. The results so far secured, however, seem to have an important enough bearing on the problem of increased meat production to justify their presentation in a bulletin, to constitute a progress report. They may be modified, of course, by study over a longer period. In estimating the possibilities for improvement, therefore, every effort is made to be conservative. The results are discussed in detail in the body of the text and are summarized at the end.

Naturally, in working with so large a range unit the results are lacking in the degree of refinement obtainable in feed yards and small-scale experiments. This, however, is more than offset by the fact that each experiment, when completed, constitutes its own demonstration on a practical scale.

JORNADA RANGE RESERVE.

The Jornada Range Reserve is located in Dona Ana County, N. Mex., in the Rio Grande trough, about 50 miles north of the Mexican boundary. It is typical of a large territory in the Southwest which, owing to natural and climatic conditions, will probably always be best adapted to the production of live stock on comparatively large holdings. The Reserve was created by Executive order, May 3, 1912, at the request of the Department of Agriculture, with the idea of securing a complete range unit for conducting experiments

and demonstrations in range management under conditions existing in southern New Mexico and similar country in adjoining States. The boundaries were slightly modified by Executive order of April 24, 1916, and at present include about 200,000 acres.

The eastern portion of the area, comprising about one-fourth of the total, is rough and broken and includes the west slope of the San Andreas Mountains, which reach a maximum elevation of about 7,600 feet, both slopes of a narrow belt of rough, gravelly hills just west of the main mountains, and a series of narrow, poorly defined valleys between the two. The remainder of the Reserve is a comparatively flat, or slightly rolling, plain, lying between elevations of about 4,100 and 4,700 feet, and broken only by a small mass of igneous mountains, the Dona Anas, at the southwest corner.

The locality is one of the most arid in the Southwest. Records for 55 years at Mesilla Park, about 15 miles southwest of the Reserve, show an average annual precipitation of 8.63 inches, with precipitation for individual years as much as 17 inches and as little as 3.50 inches. Temperatures as high as 106° are common in summer, and the region is subject to almost continuous high winds and, consequently, high evaporation. The soils of the plain are rather coarse to medium textured wind-blown sands, with patches of heavy adobe clay, usually with a rather high percentage of alkali, where water often stands until evaporated. The soils of the mountains and the outwash plains flanking them are coarse sands and gravels.

Naturally, with this combination of poor soils, low precipitation, high temperatures, and high winds, the vegetation is comparatively thin and made up of drought-resistant, semidesert species. By far the greater part of the forage, perhaps 80 per cent, is furnished by perennial grasses, of which the most important are the grama grasses, three-awn, tobosa, drop-seed, muhlenbergias, burro grass, and wolftail.[1] On large areas of the foothills and mesa, black brush, creosote bush, and mesquite predominate; but black brush and creosote bush are worthless as forage, and the mesquite is of low value. In figure 2 the vegetation is classified into range types for all of the Reserve except the mountain portion.

[1] Black grama (*Bouteloua eriopoda*) is the most important grass on the Reserve. Blue grama grass (*B. gracilis*) and hairy grama grass (*B. hirsuta*) are found only in the mountains and foothills. *B. curtipendula* is found in the mountains and on the mesa.

Next to the grama grasses in importance are three-awn grasses (known locally as "needle grasses")—*Aristida longiseta*, *A. pansa*, and *A. purpurea*.

Tobosa grass (*Hilaria mutica*).

The drop-seed grasses include several species, the most important being *Sporobolus cryptandrus*, *S. flexuosus*, *S. wrightii*, *S. airoides*, *S. auriculatus*.

The most important species of muhlenbergias are *Muhlenbergia gracillima*, and *M. porteri*.

Burro grass (*Scleropogon brevifolius*).

Wolftail (*Lycurus phlecides*).

Blackbrush (*Flourensia cernua*).

Creosote bush (*Covillea glutinosa*).

Mesquite (*Prosopis glandulosa*).

Originally the only water on the lands now within the Reserve was in a number of mountain springs, few of which furnish any considerable flow. Stock water for the plains and mesa, both on the Reserve and on the adjacent range lands, is pumped from deep wells by windmills and engines or is provided by tanks which catch the flood waters. As a usual thing, there is not enough water for the stock.

Before the lands were placed under reservation in 1912 a number of individuals had attempted to establish permanent stock ranches on them. But the difficulty and cost of sinking permanent wells, the prevalence of droughts, and severe losses discouraged the small owners, and their range rights were purchased eventually by a single stockman.[1] Up to the time the Reserve was created, however, no adequate provision had been made to prevent overgrazing or to effect improvement of the stock. Also, the area lacked adequate facilities for handling and caring for the breeding stock in a way to increase the calf crop and prevent losses. Occasionally a small quantity of concentrated feed was used to supplement the range forage, but for the most part the efforts along this line were unorganized.

RANGE IMPROVEMENT BY NATURAL REVEGETATION.

If the best results are to be secured in range management, both the requirements of the vegetation which makes up the forage crop and the practical demands of the stock must be kept in mind. These two factors are especially important on year-long ranges of the Southwest, where the time during which there is sufficient moisture for plant growth is so short.

Figure 2 shows that the range in the western portion of the Reserve is largely grama and mixed grasses, which make their main growth during July, August, and September. This forage is usually preferred by animals while it is green, but it cures well on the stalk and is good feed at any time of the year. Consequently it is especially valuable as winter range. The forage of the middle portion of the Reserve is composed principally of grasses [2] which furnish a good class of forage when green, but which have little value as feed when mature and dry. This class of range is therefore of value primarily during the growing season.

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[1] Mr. C. T. Turney, who is cooperating with the Forest Service in carrying on the studies. At the time the Reserve was created the 200,000-acre range unit was conceded to Mr. Turney by neighboring stockmen under common or range rights established through the construction of watering places and the purchase of prior rights and improvements of other owners. He leases all State lands and owns certain private lands around the wells. The Government furnishes the public lands under reservation for a period long enough to reimburse Mr. Turney for expenditures in conducting the experiments. The investigations are planned by the Government and the stockman. All fencing, water development, and other construction work, as well as extra labor in handling the stock for experimental purposes, are paid for by the cooperator in lieu of grazing fees on the Government lands. The Government furnishes the men to keep proper records of all experiments and to aid in planning new investigations.

[2] Tobosa grass, drop-seed grasses, muhlenbergias, and burro grass,

Naturally, therefore, when stock were free to choose between the two classes of range at all times of the year, the grama grass was overgrazed. Further, the grama-grass forage usually was consumed before January, when, if possible, it should have been saved for the period of range shortage from January to the beginning of the summer rains, usually in July.

Mainly to provide for improving the overgrazed grama grass by giving it an opportunity to grow and reseed itself, but in part to reserve a supply of forage for the stock during the critical spring months, the grama-grass range was fenced off from the summer range and divided into pastures.

An area of 34,545 acres, designated on the classification map as Pasture 2, was fenced in the fall of 1912. This area has been used mainly for pasturing steers and poor cows taken from the main herd during the period from January to July. Each season, during the main vegetative growing period of three to four months following the summer rains, beginning in 1913, the number of stock has been reduced to a little less than one-half the average carrying capacity of the pasture. This reduced number is kept well distributed in relation to the four watering places, in order to avoid as far as practicable having any portion of the area grazed heavily. In this way the forage plants are given a chance to develop and produce seed. During the other eight or nine months of the year, mainly after the vegetation has matured, the pasture has been stocked to about 80 per cent of its estimated maximum carrying capacity. Its full capacity has not been utilized, partly as a means of preventing its being overstocked while in course of improvement, but mainly with the idea of insuring a supply of good feed for poor cows from January to July, or later, in case of prolonged drought.

Adjoining this pasture on the west is a large area of unfenced public range, similar in character, but with a larger proportion of the pure grama-grass type. If anything, therefore, it might be considered as a little better than the pasture area. Prior to the completion of the pasture fences in 1912 both areas were grazed throughout the year, with a resulting overstocking during the growing season. Both areas also had suffered as a result of prolonged drought, which killed out a good deal of the grass. They were, therefore, near enough alike in character and condition for purposes of comparison. Year-long grazing has been continued on the outside range. It is believed, however, that the area has not deteriorated appreciably since 1912, because the seasons of 1913 and 1914 were more favorable than the average for plant growth.

Table I compares the amount and character of the vegetation on these two areas in 1916, after three years' light grazing of the pasture during the growing season.

TABLE I.—*Comparison of vegetation on grama-grass range lightly grazed during the growing seasons of 1913, 1914, and 1915 with that on similar adjoining range grazed yearlong.*

Distance from watering places.	All vegetation.[1]		Good forage.[1]		Medium forage.[1]	
	Pasture 2.	Outside range.	Pasture 2.	Outside range.	Pasture 2.	Outside range.
Miles.						
½	506	138	325	0	170	138
1	484	345	445	148	32	196
1½	556	213	517	117	38	94
2	497	322	481	168	14	145
2½	567	340	511	268	54	70
3	517	328	481	222	21	101
3½	529	375	487	208	41	165
4	.....	477	.....	351	.....	120
5	.....	549	.....	516	.....	18

[1] Figures represent square centimeters of vegetation on each 10,000 square centimeters of area, based on measurements 1 inch above soil surface.

The changes in amount and kind of vegetation on the Pasture 2 range as compared with the outside range during the three years are shown graphically in figure 1.

The striking features in connection with total vegetation are (1) that in the Reserve pasture it is higher from water out and is as great at less than one-half mile from watering places as that on the outside range about 4½ miles from water, and (2) that on the outside range it is as great at a point about 5 miles from the watering places as it is at any point in the pasture. This last point shows that the outside range is naturally as productive as the pasture, if grazed under the same system of management. Grazing at improper seasons and overstocking, however, have kept the total vegetation at 70.3 per cent of that inside the Reserve.

Total vegetation alone is not, however, a good index of carrying capacity or condition of a range, since on overgrazed areas the tendency is for good forage plants to be replaced by ones of less value. The curves for the amount of good forage plants on the two areas show that there is more good forage one-half mile from watering places in the Reserve pasture than at any point within 3¾ miles from water on the outside area, while Table I shows that there is only 49 per cent as much good forage on the outside range as in the pasture. As in the case of total vegetation, the amount of good forage on the outside range gradually increases with distance from water until at a point 5 miles from water it is as great as at any point in the pasture.

The most striking features in connection with medium forage are (1) that there is more on the outside range than in the pasture, except near water, and (2) that the amount on the outside range begins to decrease at about 3½ miles from water, the point at which the good forage begins to increase rapidly. It will be noted also that in the

pasture the amount of medium good forage begins to decrease rapidly at about the same distance from water that the good forage begins to increase rapidly. This fact is important in showing that the good forage plants will eventually crowd out the less valuable species if given a chance to grow.

Besides increasing in density and forage value, the plants on the pasture range have regained their vigor until they produce about 20 per cent more leaves and stems per plant than do similar plants on the outside range.

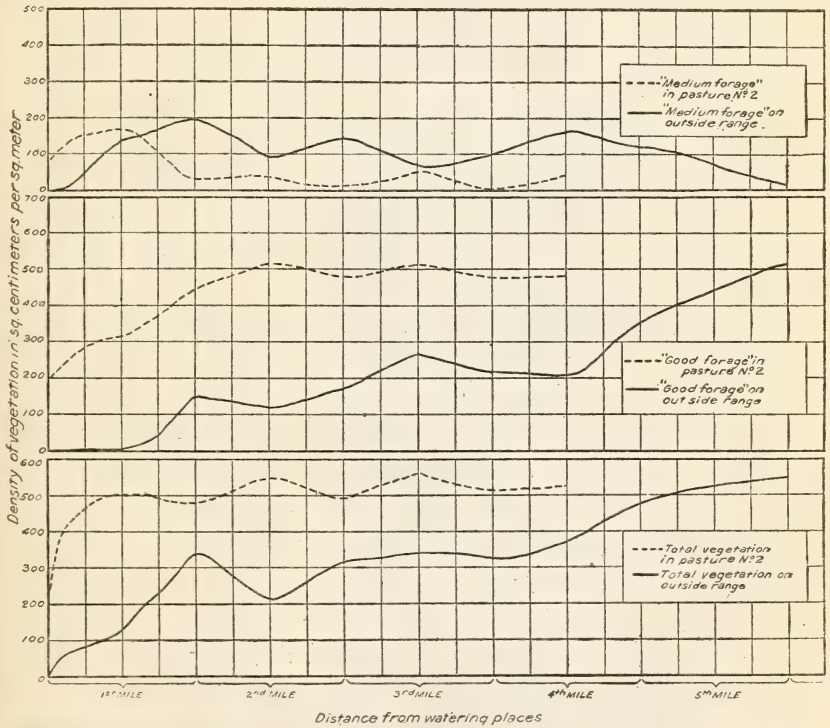

Density of vegetation in sq. centimeters per sq. meter
"Medium forage" in pasture No. 2
"Medium forage" on outside range
"Good forage" in pasture No. 2
"Good forage" on outside range
Total vegetation in pasture No. 2
Total vegetation on outside range
1st MILE
2nd MILE
3rd MILE
4th MILE
5th MILE
Distance from watering places

FIG. 1.—Comparative density of vegetation on Pasture 2, Jornada Range Reserve, and adjacent outside range.

Considering the difference in number and kind of plants and the difference in the amount of forage produced per plant, it is safe to say that the range in Pasture 2 of the Jornada Reserve has improved approximately 50 per cent in producing capacity since it was fenced in the fall of 1912, as compared with similar adjoining unfenced range, and that this improvement has been brought about primarily [1] (1) by light grazing (a little less than half the estimated

[1] Precipitation considerably above normal in 1913 and 1914 no doubt was an important aid to improvement. The measure of the improvement here given, however, is the difference in condition between the fenced ranges and adjoining unfenced range as a result of three years under different management, both ranges being under the same climatic conditions. The difference in condition reported is attributed, therefore, primarily to the improved management in effect on the controlled range.

carrying capacity) for three to four months following the beginning of the summer rains, (2) by no overstocking during the other eight months, and (3) by better distribution of stock watering places. It is believed that the area could have been used to full capacity, but not overstocked, during the eight months without retarding the rate of improvement.

These conclusions are based upon actual count and measurement of vegetation on the two ranges. It is of interest that the practical stockman who has used the range of the Jornada Reserve for 15 years believes that the range of Pasture 2 has improved about 100 per cent since it was fenced in 1913, and that 1 average acre of it is now equal in forage value to 2 acres of the adjoining outside range.

Pasture 5 of the Reserve furnishes additional proof of the value of light stocking or deferred grazing during the growing season. This pasture contains 2,815 acres of grama-grass range adjoining Pasture 2 and similar in character. It is used primarily for saddle stock and as a holding pasture when the stock are being worked. Consequently, grazing has been heaviest during late summer and early fall, when the stock are worked most.

Pasture 5 furnished during 1916 an average of 365 days' feed for one animal on 22.89 acres. Under the present system of heavy grazing during the main growing season this stocking is probably 25 per cent too heavy. The pasture is running down. In its present condition the pure grama-grass area is estimated to have a carrying capacity of 25.5 acres per head, against 20.75 acres per head for similar grama-grass range in Pasture 2. This difference of 22 per cent in favor of Pasture 2 is attributed to light stocking during the growing season.

The area designated in figure 2 as Pasture 10 also is essentially grama grass or mixed grass range, similar to that of Pasture 2. This area, like Pasture 2, has been grazed lightly during the main growing season, but has been utilized fully the remainder of the year. As a whole, the area has improved more since 1913 than any other part of the Reserve. Careful studies show that it is about 10 per cent better than similar range in Pasture 2, this difference being attributed mainly to more productive soil. Pasture 10 produces at least 50 per cent more forage than when it was fenced in 1913.

The rate of improvement of the grama-grass range under total protection against grazing has been studied by means of small fenced areas and the results compared with results secured under light stocking during the growing season as reported for Pasture 2. In both cases the vegetation had been thinned out and weakened by grazing, but there were still enough of the better forage plants left to build the range up by natural revegetation. The results to date indicate that the improvement has been approximately the same

F–25700A

HEREFORD STEERS PRODUCED AT THE JORNADA RANGE RESERVE.

F-29591A

GRAMA-GRASS RANGE, JORNADA RANGE RESERVE.

This shows pasture 10 after it had been grazed to what was considered the proper degree of utilization, and after the stock had been removed to summer range to give to the grama grass a chance to grow up for winter range.

under protection from yearlong grazing as under protection by light stocking during the main growing season.

The fact that the middle portion of the Reserve is made up largely of tobosa-grass flats, which are primarily summer range and stand heavy grazing during the growing season, has made it possible to remove most of the stock from the grama-grass range while the forage there is making its growth. The summer range, however, may need some protection during the growing season if it is to be kept in the best condition. To this end, additional fences and watering places are being provided as rapidly as possible. The biggest problem on this class of range, however, is believed to be the proper distribution of stock to secure full, even utilization.

For either light stocking during the main growing season or deferred grazing to be successful, there must be enough good forage plants remaining on the range to bring about the improvement desired by natural seeding or by vegetative development. Where the valuable forage plants have been killed out and the soil fertility reduced by water or wind erosion, many years of protection or light stocking would be required to bring about marked improvement. This condition is found frequently around watering places on unfenced range. Figure 1 shows, for example, that there is very little vegetation of any kind and practically no good forage plants within the first half mile out from water on the unfenced range.

There is believed to be no doubt as to the advisability of light grazing of the grama-grass range during the growing season. In the case of the Jornada Range Reserve, the protection of Pastures 2 and 10, for example, aside from improving the range with little loss of forage any year, has made possible the production of steers which brought $2.50 per head more than was paid for the same age and class of stock from unfenced range. Further than this, the reserved feed has made possible the avoidance of loss among poor cows during the spring months and has at the same time been a form of insurance against loss in case of prolonged drought.

Where the whole of a range unit is made up of grama grass or similar grass range, about one-third of the area should be grazed lightly during the growing season two years in succession. Each third of the unit in its turn should then be given as nearly as possible this amount of protection.

WATER DEVELOPMENT.

The importance of a well-planned water supply for cattle ranges of the Southwest can hardly be overemphasized. Where watering places are from 6 to 15 miles apart, the range near water is overgrazed and denuded, while that away from water is undergrazed. Loss from starvation increases as the distance from feed to water increases,

and under such conditions the conversion of grass into meat is generally inefficient.

At best, it is difficult to provide enough water on the Jornada Range Reserve and on other ranges throughout the Southwest. Lack of natural surface water, high cost of boring and maintaining wells, uncertainty of obtaining rain and flood water to fill storage tanks, and low carrying capacity of the range lands all stand in the way. In planning the system of water supply provision should be made first for a few permanent watering places which can be relied upon without fail in time of drought. With these as a nucleus the system should be extended by the construction of enough tanks or other development works to provide for reasonably efficient use of all forage during average years. This may appear to be faulty advice, since in time of drought all the range is needed to tide the stock over; but the expense of providing enough deep wells to insure the proper use of the range is not always justified by the number of stock the range will carry.

Observations on the Jornada Range Reserve to date indicate that fairly good utilization of plains and mesa range can be secured when the stock do not have to travel more than 2½ miles to water. This would mean permanent watering places 5 miles apart, or one to approximately 13,200 acres. On the range where grama grasses predominate this acreage under fence would carry approximately 500 head of cattle. A deep well equipped with pump, windmill, gasoline engine, and storage tank costs from $2,500 to $5,000, depending upon depth of well and current prices of materials and equipment. Add to this the investment in land, if privately owned, and the cost of fences and other improvements, and the total capital invested per head of stock would approximate $100.

As the distance between watering places increases above 5 miles, grazing becomes perceptibly uneven, with a varying degree of overgrazing around water and undergrazing beyond 2½ miles from water. Table I and figure 1 show that on the unfenced range under study the greater part of the vegetation had been killed out for a distance of 1 mile around the watering place, that the total vegetation in the first 2 miles from water is about 50 per cent of what it once was and contains a large number of poor forage species, that on the area represented by the second 2 miles from water the total vegetation is about 73 per cent of what it should be, with a still large percentage of poor forage plants, and that beyond 4 miles from water the range is in about normal condition.

Obviously, the damage to the range in this case greatly reduces the carrying capacity. The loss of both cows and calves during the summer of 1916 was much greater on the adjoining open range than on the Jornada Reserve, where feed was available within a few miles from water. Cases were observed on the outside range where, after

grazing out several miles, cows came to water in a weakened condition and drank until they dropped and later died. Where the animals do not die, the inadequate water supply is reflected in the retarded growth of young stock and in the decrease in the calf crop. The poor cows frequently lose or desert their young calves, which then either die or become so stunted in growth that they have little chance of living through the winter.

The question of water supply is a matter of range economics influenced by local conditions, value of range, stock, and cost of development. With present prices it seems safe as a business proposition to advise, for the plains range of the Southwest, permanent watering places on the basis of range for 500 head. This means a distance between watering places of 5 to 6 miles. On the poorer range of the foothills the distance will be greater.

This distribution of permanent watering places will provide for fairly even utilization, but will leave little opportunity for resting the range during the growing season, especially around water, since the animals will tend to graze the green feed near water first. Consequently, the range will be overgrazed for perhaps one-fourth mile from permanent water at best. Where soil and drainage are favorable, it will be economy to supplement the permanent watering places with a number of tanks, each of a size suitable to the situation and the range to be supplied.

In the Southwest the rains are often very local. A small portion of the range may get a good shower, whereas the range a few miles distant may not receive rain during the summer. The cattle naturally drift to where rain has fallen. When there is a tank to catch the run-off, the stock will remain in the vicinity sometimes for weeks, if the water holds out. Meantime, a shower elsewhere may freshen the range and provide temporary water.

With a system of well-distributed small tanks to supplement the permanent watering places, the range around the permanent water can frequently be rested during the growing season. At the same time range away from the permanent water will be used to best advantage; the stock will do better than when they must drift in, even from 2½ to 3 miles, to compete with several hundred others at a set of watering troughs; the cost of operating the pumps or engines will be reduced; and, perhaps most important of all, the feed near permanent watering places will be, to some extent, saved for use during dry periods when the temporary watering places fail.

This system of watering places is being developed rapidly on the Jornada Range Reserve. There are now nine permanent wells, varying in depth from 175 to 500 feet; 11 springs, five of which are of considerable value; one pipe line approximately 8 miles long, with watering places every 2 miles; and 15 tanks which hold water from

2 to 12 months. All of the wells but one were constructed before the range was reserved and are on private land. The pipe line was built in 1916 and carries the water from several mountain springs, a distance of about 8 miles, to range difficult to provide with water by any other means. At the same time it relieves the range and water about the wells. One of the tanks was constructed in 1915 and five during 1916 for the double purpose of getting the cattle nearer water and relieving the range and water about the wells, springs, and permanent tanks.

Of the 15 tanks, one or more caught some of the run-off resulting from practically every shower that fell on the Reserve in 1916. In several instances this allowed the cattle to get onto fresh feed near water and make good gains in condition and at the same time cut down the expense of pumping and gave the hard-used range a rest.

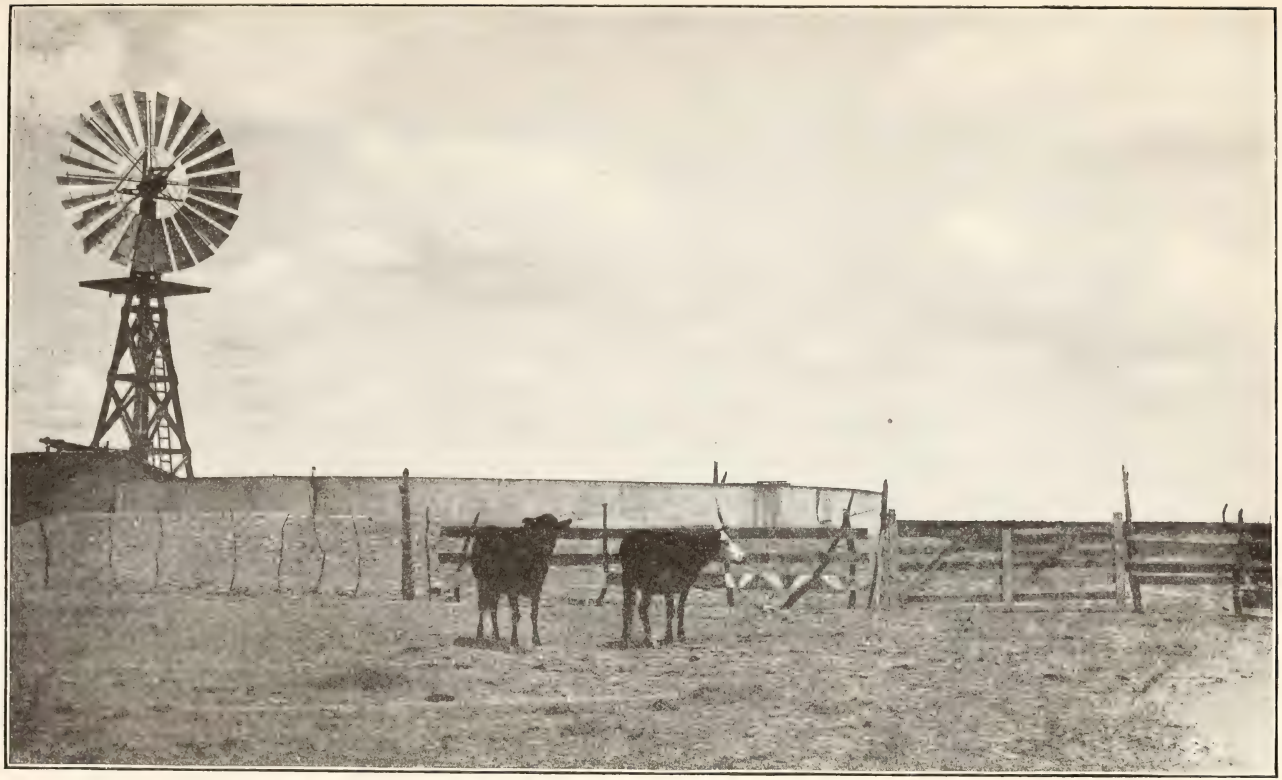
The cost of the five tanks constructed in 1916 was $787, which includes a reasonable compensation for the use of horses and mules employed in the work. The cost per tank varied from $53.40 to $309. The cost per cubic yard of earth in the embankment varied from $0.42 to $1.30, including time of travel between town and the tank site. A large part of the higher cost was for such travel. Even at this high cost the tank is considered a good investment, since it opens up range hitherto little used. The smallest of the five tanks should hold water at least two months after it is puddled and filled once; and the largest about eight months.

The range of the Reserve is now one of the best watered units in southern New Mexico. On about 80 per cent of the area stock do not have to travel more than 2½ miles to water. This will aid materially in carrying the stock through bad years with light losses and in good years will permit of increasing the number of stock. Although the pipe line and five new tanks were not available for use during the dry season of 1916, the fact that the range was as well watered as it was had its part in carrying the stock through with a loss of less than 1½ per cent for the year.

Additional water will be developed, and careful observations will be made with the idea of determining more conclusively the point at which water development for a given type of range ceases to be a good business investment.

CARRYING CAPACITY.

To decide the number of stock that a range pasture or large range unit will carry year after year is one of the most difficult problems of range management. Private pastures, as well as range lands, are often overstocked and slowly depleted unintentionally through lack of knowledge of their carrying capacity and the effect of the overstocking upon the forage production. The problem is complicated by the following facts:



F-29587A

GALVANIZED TANK FOR STORING STOCK WATER.

This tank has a capacity of approximately 100,000 gallons and has less top surface for evaporation and less bottom surface for seepage than shallow earth tanks of the same capacity. The galvanized tank cost $195 at the Reserve; grading cost $128; trampling the earth base and installing tank, $127.40; total cost, $450.40.

F-31847A

PIPE LINE FOR DISTRIBUTING STOCK WATER.

This pipe line carries water from springs in the mountains, a distance of about 8 miles out across the mesa, and provides water at approximately each mile. Note the loose, sandy soil and the mesquite and black brush with very little grass. × Indicates approximate location of springs.

1. The stand of forage is rarely uniform over any considerable acreage of range lands.

2. Different amounts of forage are produced on the same area in different years.

3. Forage plants vary in power to resist grazing.

4. Other things being equal, the carrying capacity of dry ranges over a period of years is influenced materially by the extent of grazing during the growing season of the vegetation.

5. If there are not enough well-distributed watering places to insure even distribution of the stock and even grazing over the whole area, the range is depleted around water and undergrazed away from water. This may reduce considerably the number of stock the area will carry.

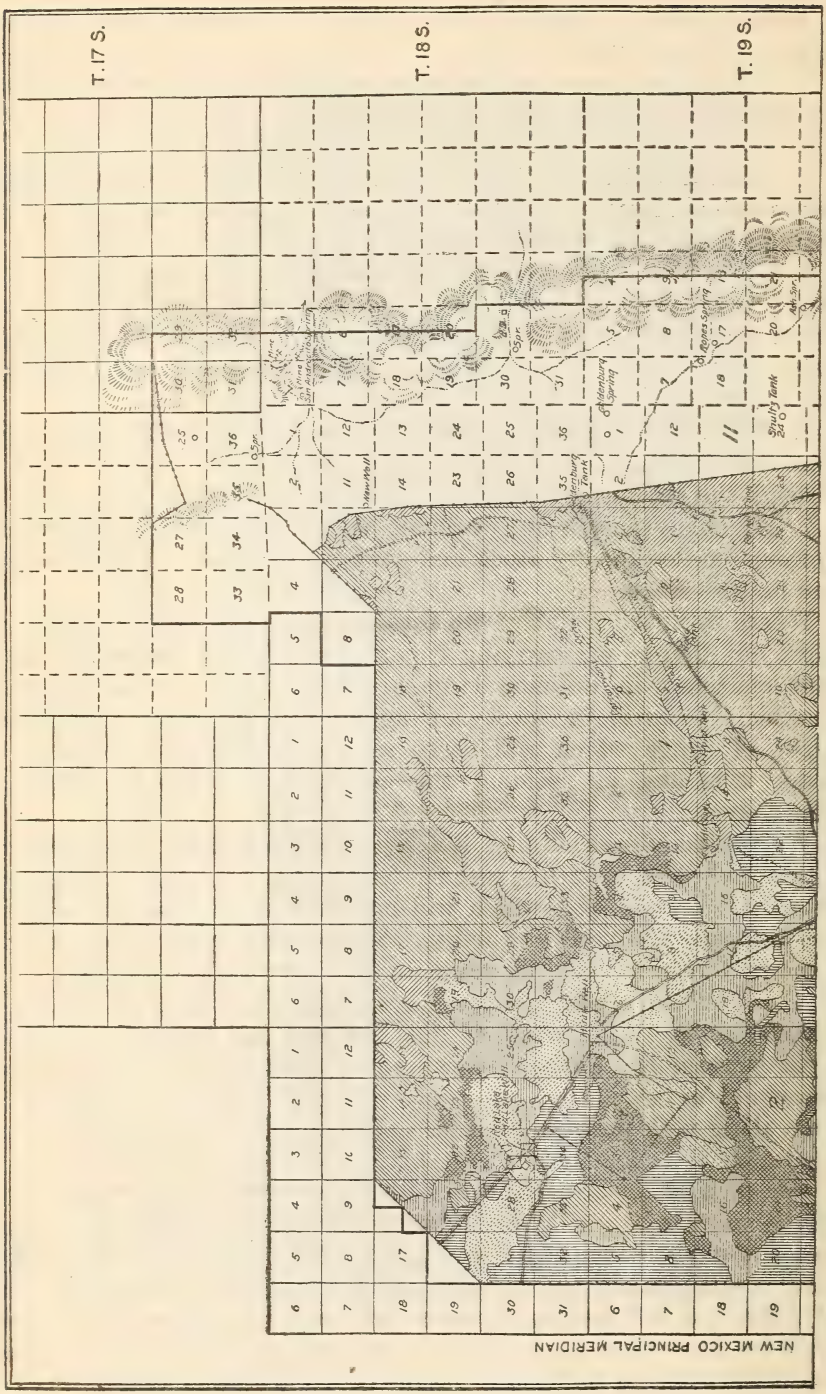
6. The number of stock carried will depend somewhat upon the condition in which the animals are kept—whether merely carried through the period, kept in good condition, or fattened.

7. Reliable data are not available as to the comparative amount of range needed for dry stock and cows with calves, or for yearlings and mature stock.

Where so many variables are involved, it is obviously difficult to work out figures for carrying capacity which will insure 100 per cent efficiency in utilizing large areas of range. It is believed possible, however, to work out figures for the more prominent types of range which will serve as a safe guide in stocking a given unit and in deciding the comparative value of different range areas.

Within the Jornada Range Reserve was found range varying from that which will furnish yearlong feed for one mature animal on about 20 acres to that which will barely support a mature animal on, perhaps, 100 acres. Further, the different types of range are somewhat intermixed. To determine the comparative grazing value of the different types, a range survey was made of approximately 150,000 acres. As a result of this, the area has been divided into eight more or less distinct types and an estimate made for each of the stand of vegetation the stock will eat. This type classification, along with pasture divisions and watering places, is shown in figure 2.

For each of the 13 pastures of the Reserve record has been kept of the number of animal days' feed furnished each month and year, and of the percentage of the vegetation left unused or the percentage of overstocking. From these data and the data secured by the classification and grading of the range, tentative figures of carrying capacity have been worked out. They will, of course, be amended when necessary to conform to results over a period of years.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NEW MEXICO PRINCIPAL MERIDIAN

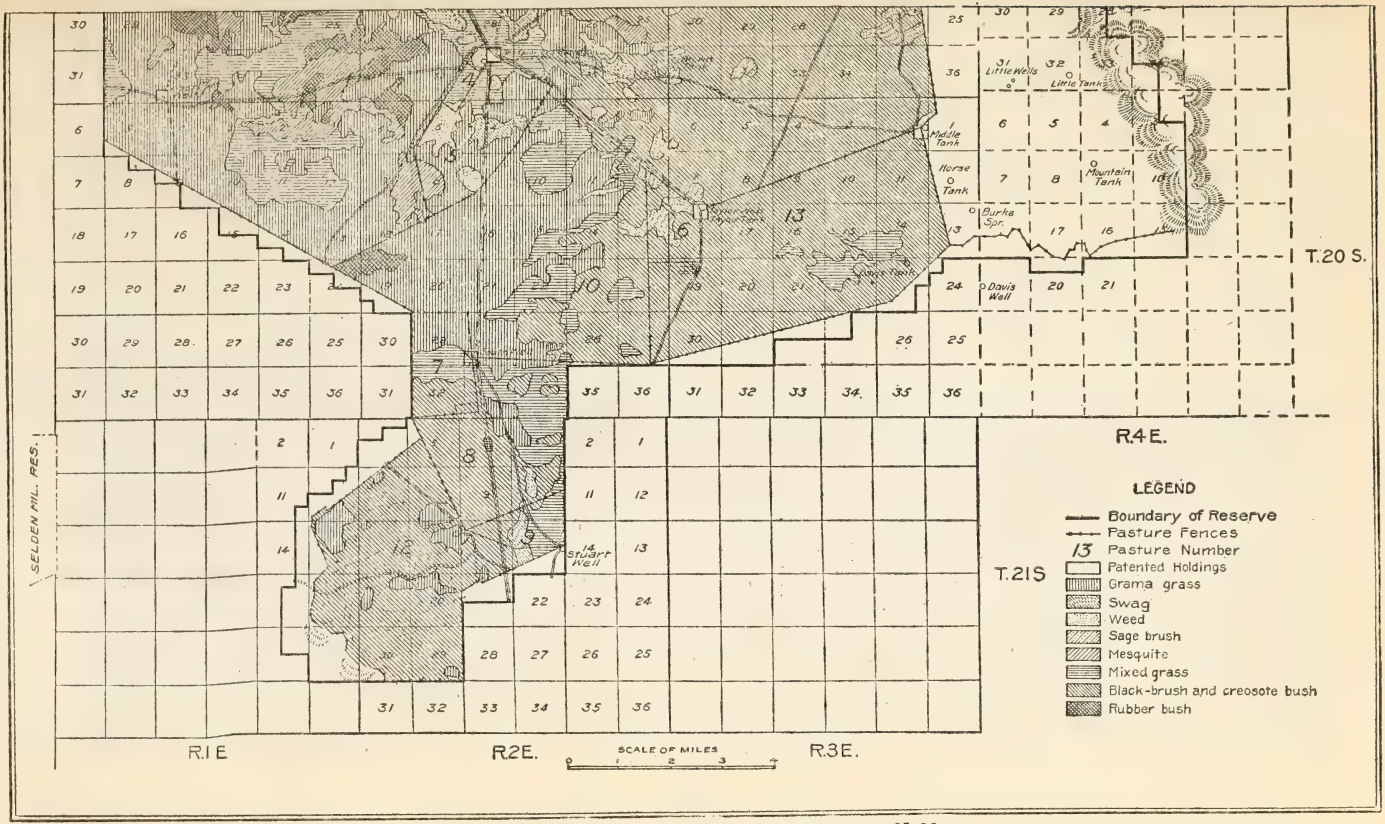


FIG. 2.—The Jornada Range Reserve, Dona Ana County, N. Mex.

THE RESERVE AS A WHOLE.

Of the 202,000 acres of the Reserve, approximately 10,000 acres of the mountain area are inaccessible, leaving about 192,000 acres either fully or partly used. From May, 1915, to April 30, 1916, the average number of stock grazed, including weaned calves and horses, was 4,632.16, or an average of one head to 41.45 acres of usable range. Taking into account the surplus or shortage of forage in each of the 13 pastures, the estimated carrying capacity of the whole Reserve in its present condition and stage of development is 5,030 head throughout the year, not including unweaned calves. This is at the rate of 38.1 acres per head. The Reserve would no doubt carry this many, provided, as at present, supplemental feed were used to prevent the loss of poor cows. This would be necessary in a measure if only 4,000 head were grazed, as there would still be some stock in need of special attention. These figures for the Reserve as a whole are of interest merely as showing average carrying capacity over large territory, combining plains, foothills, and mountain range, such as is found throughout southern New Mexico outside of the National Forests.

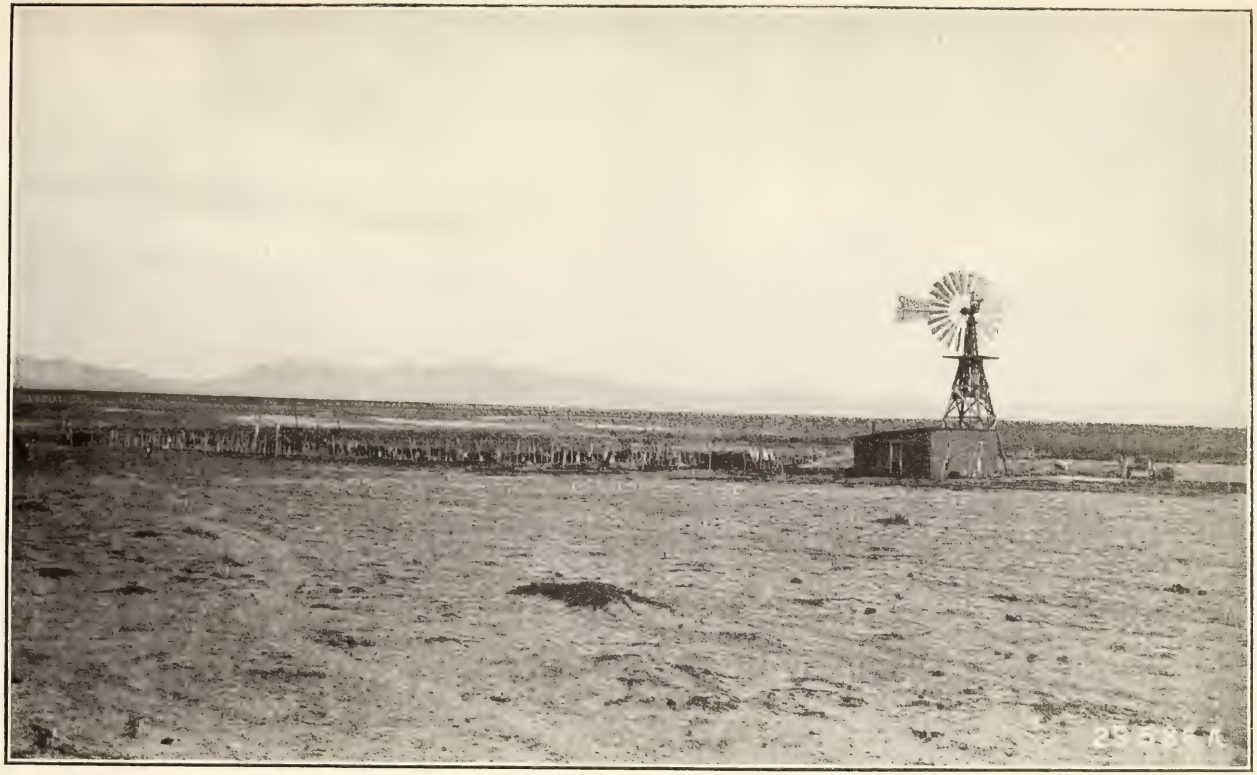
As a whole, the range of the Reserve is in better condition than the unfenced ranges and is better supplied with stock-watering places. Aside from these advantages, better utilization can be secured under fence. Consequently, for a similar area of unfenced range in its present condition and development 50 acres per head would be a conservatively low figure, if the range and stock are to be kept in reasonably good shape. The carrying-capacity figures for the main types of range, however, will serve as better guides in estimating the number of stock a given range should support.

GRAMA-GRASS (WINTER) RANGE.

JORNADA RESERVE.

The plains where grama grasses form the bulk of the forage constitute, perhaps, the most important type of range in the Jornada Range Reserve and vicinity. The investigations to date show that this type in normal condition, if grazed lightly during the main growing season, will furnish 365 days' feed for one animal per year on from 20 to 30 acres, according to the proportion of range types other than grama grass.

Pasture 2 of the Reserve (fig. 2), containing 34,545 acres, has supported an average of 1,045 head of stock, yearlings and above each year for three years—May 1, 1913, to May 1, 1916. From May 1, 1913, to May 1, 1914, it supported an average of 1,260 head. It is estimated that the surplus feed averages 20 per cent of the total. The pasture, then, if fully utilized, would have carried an



F-29580A

OVERGRAZED RANGE NEAR A WATERING PLACE JUST OUTSIDE THE JORNADA RANGE RESERVE.

Virtually all the vegetation has been destroyed by overgrazing and trampling brought about by congestion of a great many cattle on inadequately watered range.

F-29590A

WATERING PLACE ON THE JORNADA RANGE RESERVE.

Contrast with watering place on adjoining outside range, Plate V. Vegetation here extends up to the well.

F-29595A

BLACK-BRUSH TYPE. SCATTERED STAND OF BLACK BRUSH (FLOURENSIA CERNUA) WITH TOBOSA GRASS (HILARIA MUTICA) AND BURRO GRASS (SCLEROPOGON BREVIFOLIUS) GROWING BENEATH THE BRUSH.

This type occupies several thousand acres of the Reserve. It is often referred to as "summer range."

F-31848A

TYPICAL SANDHILL MESQUITE TYPE.

Very little forage is produced on this type of range.

average of 1,307 head, or at the rate of 26.4 acres per head for all types of range together.

In Table II the grazing value of the various other range types in Pasture 2 are compared with that of the grama-grass type.

TABLE II.—*Acreage and carrying capacity by types of range in Pasture 2, Jornada Range Reserve.*

Type of range.	Acres in Pasture 2.	Acres of other types equivalent to 1 acre of grama grass in forage value.	Average[1] acres per head per year when 80 per cent is utilized.	Estimated average acres per head per year when fully utilized.
Grama grass	14,473	1	25 95	20.76
Tobosa grass	1,658	.92	24.56	19.64
Mixed grasses	6,514	1.08	28.06	22.44
Weeds	721	2.42	62.83	50.28
Sagebrush sandhill	423	1.59	41.50	33.20
Mesquite sandhill	5,922	2.98	74.09	59.27
Rabbit bush	4,834	2.10	54.59	43.67

[1] Average of 3 years, May 1, 1913, to April 30, 1916.

The condition of the grama-grass range of Pasture 2 is now about normal. In this case about 21 acres per head, yearlings and above, will furnish 365 animal-days' feed over a period of years, provided the range is not stocked heavier than approximately one animal to 40 acres during July, August, September, and October. During the remainder of the year enough additional stock can be grazed to make up for the reduction during the growing season.

This conclusion is substantiated somewhat by the records for Pasture 5 (fig. 2). The grama-grass range of Pasture 5 actually furnished 365 animal-days' feed per 20.4 acres during the year from May 1, 1915, to April 30, 1916, though the heaviest grazing was during late summer and fall, when it should be light. Study of the vegetation on this pasture shows that the condition of the range is only approximately 75 per cent as good as similar range in Pasture 2. This and the fact that there was a shortage of feed in Pasture 5 led to a decision that the pasture was 25 per cent overstocked during 1916. With a reduction of 25 per cent in the total grazing during the year, and light stocking during the growing season, it is estimated that the forage production can be increased 25 per cent in three to four years. The area will then carry stock at the rate of 365 animal-days' feed annually on from 20 to 21 acres of the grama-grass area. If heavy grazing during the growing season is continued, the carrying capacity will, without doubt, be further reduced.

These two pastures are typical of large areas of plains range where the grama grasses predominate. For such range in good condition,

therefore, approximately 27 acres of the combined types, or 21 acres of grama-grass type alone, will furnish 365 animal-days' feed per year, for yearlings and above, over a period of years, provided it is stocked at not more than one-half this rate during July, August, September, and most of October. In case of prolonged drought, supplemental feed will probably be necessary. Conditions resulting from extremely prolonged drought should be met by some plan similar to that suggested under prevention of losses, rather than by greatly understocking over a period of years.

UNFENCED RANGE.

A rough classification was made of unfenced range [1] joining Pasture 2 and similar in character. Of approximately 98,530 acres, about 66,485 is grama-grass type, and the remainder of other range types of less grazing value than the grama grass. The best information available indicates that this area has been grazed by a yearly average of about 3,750 head of cattle, yearlings and over, an average of 26.3 acres per head for all types. One acre of the grama-grass range was estimated as equal to 2¼ acres of the other types. On this basis the total of 98,530 acres would be equivalent to 80,725 acres of grama grass, or an average of 21.53 acres per head.

This range was considered overstocked at least 25 per cent for the quantity of feed it produces, to say nothing of the absence of a chance to recuperate. The estimated carrying capacity for the area as a whole in its present condition, therefore, is about 35 acres per head, and for the grama-grass type 27.9 acres per head. The estimated carrying capacity of grama-grass range in Pasture 2 of the Reserve is 20.76 acres per head, or 34.4 per cent greater than that of this outside range of similar character.

In the discussion of range improvement by natural reseeding it was shown that the total amount of vegetation on this outside range is only 70.3 per cent of that in Pasture 2, and the good forage only 49 per cent, and the conclusion was drawn that Pasture 2 has increased approximately 50 per cent in forage-producing capacity since 1913. This apparent discrepancy between the conclusion relative to the two ranges based upon vegetation studies alone and that based on the number of stock actually carried is accounted for by several facts. First, the stock in Pasture 2 have been carried in good condition, and poor cows have actually improved during critical periods of the year. Stock on the outside range have merely been carried over, with some loss from starvation. Second, the estimates of surplus feed in Pasture 2 were purposely low, and the estimates of overstocking on outside range were likewise low. Further, the data as to number of stock on the outside range are estimates only.

[1] The range here referred to is described under the chapter on range improvement by natural revegetation, page 5.

These differences in intensity of utilization and condition of the stock, together with the conservative estimates where actual measurement or count was not possible, will more than account for the 15 per cent difference in forage produced and number of stock actually grazed. Considering that the problem was approached by two independent lines of study, the result is thought to justify the tentative conclusions.

SUMMER RANGE.

The other types of range are so intermixed that on no large area of any one has it yet been possible to obtain accurate figures of carrying capacity. For the combination of types, however, making up what may be considered the summer range, including the tobosa-grass and burro-grass flats, and the black brush-creosote bush type extending from the flats into the foothills, the figures for the area designated in figure 2 as Pasture 13 are fairly representative.

This pasture contains 9,517 acres, of which 8,912 is a combination black brush-creosote bush type. It receives the surplus run-off from an area twice to three times its size. There are many small flats which flood and which have a high carrying capacity for summer range. The general average, however, is greatly lowered by the dry ridges and slopes which support little but creosote bush or black brush of no value as forage. Black grama and other grasses among the brush type furnish considerable feed on the drier parts of the flats.

During 1916 this pasture was grazed heavily in summer and lightly in winter, and furnished, on an average, 365 days' feed for one animal (cows, with unweaned calves, and bulls) on 37.4 acres. The area is, perhaps, a little better than the average for this class of range. Pasture 1, containing 74,714 acres, furnished yearlong grazing during 1916 at the rate of 45.2 acres per head. It was estimated to be only 90 per cent stocked, which would give a carrying capacity, if fully stocked, of 40.7 acres per head. The indications are that this class of range as a whole will support one animal throughout the year on from 38 to 45 acres, according to the proportion of flats subject to flooding and to the extent of the range similar to that shown in Plate VIII.

MOUNTAIN RANGE.

The lower hills and mountain range on the west slope of the San Andreas Mountains in 1916 furnished 365 days' feed for one animal (yearlings and horses) on each 53.33 acres. The area was regarded as about 15 per cent overstocked, since the animals did not hold up well, and portions of the range near water were slightly overgrazed. This area, therefore, will support only one head to each 60 acres until more water is developed. There are a number of barren areas and inaccessible spots. Three additional stock-watering tanks were con-

structed in 1916, which will slightly increase the carrying capacity and aid in bringing the stock through in better shape. The general character of this range is shown in Plate IX.

INCREASE IN CALF CROP AND IMPROVEMENT IN GRADE OF STOCK.

Reports received from stockmen during 1914 in connection with an investigation of live-stock production on western ranges showed an average calf crop of 66 per cent for New Mexico and 57 per cent for Arizona.[1] This figure for New Mexico as a whole is believed to be too high for the ranges of the southern part of the State. Granting that it is not, however, there would still seem to be a good chance for a bigger calf crop, provided it is practicable to keep the breeding stock, both cows and bulls, in better condition throughout the year and to secure the proper distribution of bulls.

In giving the additional feed and care required for an increase in the calf crop, the possibility of improving at the same time the average grade and value of the individual animal should not be lost sight of. Supplemental feed should be given to a cow or bull capable of producing a calf worth $30, in preference to an animal capable of producing a calf worth only $25 or $27.50. Preference should also be given an animal capable of producing a steer with the qualities necessary for good feeders.

When the studies to determine the possibilities of increasing the calf crop and improving the grade of stock were begun in 1915, the female stock of breeding age on the Jornada Range Reserve numbered approximately 1,950 head. The bulk of these were fairly good grade Herefords; but about 500 or 600 head were of low grade, off color, and old Mexico stock.

Five hundred of the best Hereford cows and heifers and 20 of the best Hereford bulls were selected in the summer of 1915 and given a summer pasture and a winter pasture away from other stock. In November the cows were dehorned and branded with a special brand for this herd and its increase. The record started November 19, 1915, with 500 cows, 20 bulls, and no calves.

Early in 1916 the 20 bulls were replaced by registered Hereford bulls purchased in the Panhandle of Texas. The least desirable of this lot have, in turn, been replaced by the pick of a carload of registered Herefords purchased of the Kansas Hereford Breeders' Association in November, 1916.

Until February 1, 1916, both female stock and bulls were left on the range. The bulls and a few thin cows about to drop calves were then placed in a small pasture and fed cottonseed cake to supplement the range feed. The number on feed was added to from time

[1] Report 110, U. S. D. A. The Meat Situation in the United States, Part II, p. 23.

F–31849A

TOPOGRAPHY AND VEGETATION OF SAN ANDREAS MOUNTAINS, JORNADA RANGE RESERVE.

This shows the sparse vegetation and steep, rocky slopes. The carrying capacity of this area is about 60 acres per head.

F-32471A

TYPE OF BULL USED IN THE SPECIAL 500-HEAD HERD BREEDING ON THE JORNADA RANGE RESERVE.

This bull weighed 1,720 pounds in breeding condition when 2½ years old.

to time until, by the end of March, 225 head were being fed a small quantity of cottonseed cake each time they came to water. The feeding was discontinued April 19, when the grass started to grow. The spring was a dry one, however, and range forage practically stopped growing in early June. Consequently, 146 cows with small calves were again started on cottonseed cake on June 7 and fed to to July 19. The cows were not in danger of starvation, but were thin. The feeding was done primarily to keep them in thrifty condition so as to insure, if possible, a good calf crop the following year.

During the feeding from February 1 to April 19, a total of 18,850 pounds of cottonseed cake was fed in 15,588 feeds, or slightly over 1 pound per head at each feeding. A total of 6,800 pounds was fed in 3,528 feeds during June and July, making a total of 25,650 pounds of cake fed during the year. If all of the 500 cows and 20 bulls are considered, this would amount to slightly less than 50 pounds per head.

In the matter of range the special herd had no advantage over the other stock except to be by themselves. This made it possible to watch them more closely and pick out those in need of special feed. Approximately half of one man's time was spent in caring for the herd. This involved riding the fences, looking after watering places, feeding, and general care.

From the beginning of the herd record, November 17, 1915, to November 17, 1916, a total of 406 calves were branded. With a herd of 500 cows, this amounts to a calf crop of 81 per cent. Over 96 per cent of the calves had good Hereford color and markings and for the most part had good backs, straight tops and underlines, and as a whole showed up well. It is true that the experimental herd were selected cows, and it is possible that the selection of a number of 2-year-old heifers slightly increased the number of calves. This advantage, however, was probably offset by the extra handling of the stock when they were selected, dehorned, and branded, and by the dry year. It is hoped that an average calf crop of 81 per cent or better can be produced without materially increasing the quantity of supplemental feed.

The loss for the year amounted to five cows and, so far as known, five calves, four of which died before branding. This loss of approximately 1 per cent is exceptionally small and probably will be exceeded slightly in future years, even with more favorable range conditions and better care. It is believed, however, that the average loss in this herd can be kept within 2 per cent for cows and 4 per cent for calves.

Selection of the 500 cows for the special breeding herd left about 1,450 female stock of breeding age in the main herd on the Reserve.

Most of these were run throughout the year on Pasture 1 (fig. 2), containing 74,714 acres, mainly of the black-brush and creosote-bush type, and rolling mesquite and sandhill range, with a small proportion of tobosa-grass flats. During the summer of 1915, 325 low-grade, off-color, and otherwise undesirable cows were cut out and sold in one bunch, and a number of others were butchered for the local market. In the fall of 1916 a lot of 101 head were cut out and sold as "canners." The culling of nearly 500 head and their replacement by heifers of good Hereford grade has improved vastly the appearance as well as the average grade and value of the breeding herd. Similar culling has been done among the bulls and will be continued each year. Sales will be made primarily from the culls and from the less desirable heifers produced, reserving selected heifers for the ranch herd.

The management of this main herd was similar to that of the special herd, but less intensive. About 75 per cent of the bulls and 2 per cent of the poorest cows were fed cottonseed cake at the rate of 1¼ pounds per head each time they came to water, usually every day, during February, March, and April. The stock of this herd were not maintained in as thrifty condition as those of the special herd during the early spring, but were equally as good in late summer and fall.

From 1,522 cows, 1,053 calves, or 69.2 per cent, were branded in 1916, as against 81 per cent for the special herd, making an average of 72 per cent for the Reserve as a whole.

The known loss from this herd was 8 cows, a little over one-half of 1 per cent, and 11 calves, a little over 1 per cent. The pasture is large and rather rough and brushy, making it difficult to determine the loss with absolute accuracy. The whole area was worked thoroughly several times during the year, however, and it is not probable that any appreciable loss was overlooked.

On a unit as large as the Jornada Range Reserve it is difficult to get accurate records of the calf crop, even when under fence, and next to impossible to secure corresponding data for large herds on adjoining unfenced range. From such data as could be secured it seems doubtful whether the average calf crop on range lands in southern New Mexico in 1916 was as high as 60 per cent. This figure is believed to be rather high for the calf crop over a period of years back. Even taking as an average the 66 per cent calf crop reported by stockmen for New Mexico as a whole, the average calf crop of 72 per cent for Jornada Reserve, with 81 per cent for the special herd, shows marked possibilities.

The most important single factor influencing the calf crop under conditions such as those on the Jornada Reserve is the condition of the breeding stock. Cows which are barely able to totter to and

from feed and water can not be expected, after dropping a calf, to breed as soon again, or in as large proportion, as those which are kept in thrifty condition. Unless the range is supplemented by concentrated food, a large percentage of cows, especially those suckling young calves during the winter, are very thin in flesh and low in vitality by the time green grass comes on southern New Mexico ranges.

The biggest possibility for increasing the calf crop lies in keeping these cows, not fat, but strong and thrifty enough to enable them to breed promptly, and in feeding the bulls so that they will be able to do the work expected of them. Although the one year's results at the Jornada Range Reserve do not justify final conclusions as to the results, over a period of years, from better care and the use of supplemental feed, they do justify serious consideration by stockmen of employing this means to increase the calf crop.

Beginning in 1917, from 50 to 75 of the least desirable cows originally selected for the 500-head special breeding herd will be culled out and replaced by heifers selected from the 1915 calf crop of this herd. These heifers will be kept from the bulls until approximately 20 months old, since it is believed that the general practice in the Southwest of breeding yearling heifers has a tendency to decrease the average size of the stock and to increase loss, without increasing the number of calves produced over a period of years sufficiently to compensate for the disadvantages. This point will be carefully observed. Each year part of the original 500 head will be replaced by selected heifers, with the idea of building up the grade of the herd. The cows taken out and the surplus of heifers from the increase will be used to replace less desirable breeding animals in the main herd of the Reserve.

PREVENTION OF LOSS.

All things considered, the biggest hazard of the stock industry on the desert and semidesert ranges of the Southwest is the occurrence of heavy losses during years when there is little or no rainfall. In the past such losses often have wiped out in one season the accumulated profits of years. The southwestern range stockman is confronted constantly with the possibility that next year may be a bad one.

HOLDING RANGE FORAGE FOR USE DURING CRITICAL SPRING MONTHS.

In average years the most dangerous period is from February to the beginning of the summer rains, usually in July. When no rains come and the dry period extends throughout the year, the situation is critical. The first step in providing for both the average and the emergency year should be to save a good portion of the grama-grass range for use from February to July. Some range must be available

for this period, and it is economy to hold the grama grass, since it retains its feeding value better than other range.

This practice has worked well at the Jornada Range Reserve. Pasture 10, of 12,293 acres, mainly grama grass, is reserved largely for the 500-head breeding herd from November or December until green feed comes the following year on the summer range. This means that the bulk of the feed of Pasture 10 is available for the critical part of the year. Pasture 2, of 34,545 acres, mostly grama grass, is grazed lightly during the growing season, mainly by steers and by breeding cows which need extra care during winter and spring. About 250 thin cows and their calves from the main breeding herd were carried through the critical dry period of spring and summer in 1916 by the dry grama grass reserved in Pasture 2. Without this feed a number of them would undoubtedly have died. The special breeding herd of 500 was held mainly in Pasture 10 until July. Loss from starvation was prevented by supplementing the dry grama grass with a small quantity of cottonseed cake.

In order to have additional range for the breeding stock in especially critical years, about one-third of the carrying capacity of the Reserve in average years is used for steers. In good years the steer stock can be increased as a means of completely utilizing the forage and in bad years, if necessary, part or all of the steers can be sold, thus releasing one-third more range for the breeding stock. There is usually a ready market during the spring and summer for steers for shipment to northern ranges, so that sales can be made without any great sacrifice. In addition to preventing loss, this plan makes it possible to build up the breeding stock without interference from forced sales of female stock.

This plan worked well in 1916. Range conditions were observed carefully during the dry spring, and on May 1 1,573 head of steers were sold. In average years they would have been replaced by purchase of yearling steers, but owing to the unfavorable season this was not done. The extra feed was held for the breeding stock.

CONCENTRATED FEED (COTTONSEED CAKE) TO SUPPLEMENT RANGE FORAGE.

Although the plan of reserving range feed and, when necessary, reducing the number of steers by sale will aid a good deal in reducing the loss from starvation; it will not do away with it altogether, nor will it prevent the breeding stock from getting too thin, nor insure that the growth of calves and young stock will not be retarded greatly. It will be necessary, even in average years, to supplement the range forage with some concentrated feed, such as cottonseed cake. The percentage of the stock which will need feed and the period of feeding will depend largely upon the year.

F-32470A

YOUNG BULLS FOR USE ON THE JORNADA RANGE RESERVE.

These registered bulls were bought at the Kansas Hereford Breeders' Association sale in November, 1916.

F—25728A

MAKING ENSILAGE OF SOAP-WEED (YUCCA) TOPS.

The heads were run through an ordinary ensilage cutter into a pit silo.

The spring and summer of 1916 were more severe than the average and, although there was a good deal of dry grama grass available up to the time the rains came, it was advisable to feed considerable cake, mainly to breeding cows, weaned calves, and bulls.

A total of 25,650 pounds of cake was fed to the special herd of 500 breeding cows and 20 bulls. About 75 per cent of the herd were "caked" at one time or another. The cake cost approximately $40 per ton, or a total of $534 at the feed yards on the Reserve. As a result of this feeding not a single animal was lost from starvation, the calves were kept growing in spite of the fact that many of them were mothered by 2-year-old heifers, and the cows and bulls were kept in fair breeding condition.

There is some question as to the advisability of feeding cake to calves weaned in the fall from the time of weaning until green grass comes. The advantages of such feeding are that it keeps the calves growing, or in condition to make rapid growth when green feed comes; that it prevents loss from starvation; and that it makes it possible to take the calves from thin cows at an earlier age than is advisable where the calves must winter on dry range alone. These considerations are important, but it is difficult to measure them in dollars and cents for comparison with costs. Observations over several seasons, however, indicate that such feeding pays.

During the fall and winter of 1915–16 about 700 head of weaned calves were fed on cake to supplement the range feed. The quantity of feed used and costs were as follows:

37.2 tons cottonseed cake at $36 per ton at railroad	$1,361.50
Hauling cottonseed cake to Reserve from railroad at $3 per ton	111.60
145 bales alfalfa hay	72.50
Hauling alfalfa hay to the Reserve	9.00
Labor and board for feeding, 6 months at $40 per month	240.00
	1,794.60
Average cost per head for 700 head	2.56

The alfalfa hay was used in mixture with the cake until the calves learned to eat the cake alone. The average feed of cake was 1.8 pounds.

The value of keeping the calves growing is apparent in the sales of steers. From the 700 head caked, 100 head of long yearlings were cut out and placed with the 2-year-old steers for sale May 1, 1916. The steers were sold by the head, with the privilege of a 10 per cent cut. When the cut was made, 101 of the older steers were cut back and finally sold at $10 per head less than the sale price for the herd. Not one of the caked yearlings was included in the cut. The 2-year-olds cut back had not been caked as calves following weaning. The remainder of the steer calves fed during the winter of 1915–16 were

held on the Reserve during the summer and winter and were sold for May delivery, 1917, at from $2 to $2.50 per head more than was paid by the same buyer for other steers of the same age in the vicinity of the Reserve.

It would seem, therefore, that the increased value of the calves as a result of caking more than paid for the cost of feed and feeding, to say nothing of the small loss of calves and the advantage to thin cows in having their calves weaned early. The total loss of calves and yearlings from starvation on the Reserve during 1916 was three head, two of which were "dogie" calves not fed, and the third apparently died of starvation in the pastures through failure to come in to feed and water. Up to April 1, 1917, equally good results have been secured in eliminating loss from starvation.

PROVIDING ROUGHAGE.

The feeding of cottonseed cake does not do away with the necessity for roughage, either in the form of range forage or in some other form. The dry cured forage on the range will usually meet this need, but in case of prolonged drought, such as occasionally comes in the southwest, the supply of range feed may become exhausted. To meet such emergencies, it would be a distinct advantage to accumulate a reserve supply of roughage in the form of hay or ensilage during the more favorable years.

With this in view, two pit silos, lined with cement, were constructed in 1915. In August, one of about 20 tons' capacity was filled with tobosa grass and a small quantity of soap weed. The tobosa grass was cut just before it matured and was run through an ensilage machine into the silo. Late in the winter of 1916 the silo was opened and the ensilage fed to 2-year-old steers and milk cows. Even though the stock were thin, they refused to eat the ensilage to any extent. A small quantity of tobosa grass was cut and put up as hay. This also the stock refused to eat unless starved to it. It is doubtful if tobosa grass will be of any real economic value, either as hay or ensilage.

The other silo has a capacity of about 200 tons. In early December, 1915, about 150 tons of soap weed (*Yucca elata*) was gathered and run through an ensilage cutter into this silo. The top was covered with straw and earth and left closed until March, 1916. The silo was then opened, and a few poor cows were fed a ration of the soap-weed ensilage once a day. Most of them learned to eat it quickly and with relish. About 10 tons of the ensilage was fed with encouraging results. The pit was then closed; it will be opened later, when there is need of supplemental feed.

During the short interval between filling and opening the silo the coarse fiber of the soap-weed leaves had softened a good deal; but it

was still rather tough, and the stock had difficulty in eating it. This was due, in large part, to the fact that the ensilage machine used would not chop the thick, tough leaves fine enough. Portions 6 inches long were not uncommon. A machine which would chop the leaves into smaller pieces would improve the ensilage a good deal.

The soap weed can be cut, hauled, and put into the silo at a cost of $2 to $2.50 per ton, not including cost of the silo. It takes two or more years after the first cutting for the plants to produce a growth of leaves large enough for a second. It would not be practicable therefore to fill a silo each year in the same place. This, of course, is something of a disadvantage.

Though the test has just begun, it seems probable that soap weed may prove of considerable value as ensilage. Further tests will be made to determine feeding value and secure more complete data on costs and returns.

PREVENTION OF BLACKLEG.

During the month of May, 1915, more than 50 head of young steers out of approximately 1,000 head in one pasture of the Reserve died of blackleg. Prior to this time losses were rather heavy among the weaned calves. A campaign for systematic vaccination of all stock between the ages of approximately 5 months and 20 months was started in the fall of 1915 and has been continued to date.

The vaccination is done, for the most part, during the fall round-up and again during the early spring. The idea is to vaccinate twice a year as a preventive of blackleg, not as a cure. About 2,500 doses of the Government blackleg vaccine were administered during 1916. The vaccine was prepared carefully and administered carefully and every reasonable precaution taken to insure thoroughness. The area is large, however, and it is next to impossible to get all the animals for vaccination at the proper time. Consequently a small loss is expected. The test, however, is a demonstration of what can be accomplished under range conditions on a large scale.

A loss of 27 head during 1916 was attributed to blackleg; but in the case of at least three of these there was some doubt as to the cause of death, since the animals were not found until several days afterwards. This means a loss for the year of approximately 1 per cent of the average number of stock between the ages of 5 and 20 months, but less than 1 per cent of the total stock of susceptible age. On the basis of the average number of stock on the Reserve during the year, it is equivalent to a loss of a little over one-half of 1 per cent. One stockman on range adjoining the Reserve reported a loss of 100 head from blackleg during the first half of 1916 from approximately the same number of stock as are on the Reserve.

TOTAL LOSS.

The total losses on the Reserve from June 1, 1915, the time that the department representatives began an active part in the campaign against loss, until December 31, 1916, was 54 head of all classes, or at the rate of 1.9 per cent annually. The total losses from January 1, 1916, to December 31, 1916, were 66 head, or 1.5 per cent. The 1916 losses included 13 cows, 2 bulls, 35 yearlings, 4 branded calves, and 12 unbranded calves. Possibly a few head were missed, so that the total might be slightly higher, but not appreciably so.

Reports received from stockmen in connection with the investigation of live-stock production on western ranges in 1914 showed average losses for New Mexico as follows: Calves up to 12 months of age, 10.6 per cent; yearlings, 5.6 per cent; stock over 2 years old, 5.8 per cent. If these figures are approximately correct, and it is believed that they are, the small losses at the Jornada Range Reserve since June 1, 1915, show decidedly encouraging possibilities for reducing losses from starvation, blackleg, straying, and other causes. Records for a period of years will be necessary for comparison with the figures cited for New Mexico as a whole. The results at the Reserve to date, however, justify serious consideration by stockmen. Systematic vaccination is possible under range conditions. It should be done as a preventive, and not as a cure after the disease is prevalent in a herd. Much can be accomplished also in preventing loss from starvation, even on the open range, though it can not be handled with the same efficiency as on fenced areas.

CONCLUSIONS.

RANGE IMPROVEMENT BY NATURAL REVEGETATION.

Primarily as a result of (1) reducing the number of stock during the main growing season of about four months—July to October—to about half the average number the area will carry for the year, (2) not overstocking during the other eight months, and (3) better distribution of stock watering places, grama-grass range on the Jornada Range Reserve has improved in three years at least 50 per cent, as compared with similar adjoining unfenced range grazed yearlong. Observations to date indicate that range thus lightly grazed during the main growing season has improved approximately to the same extent as similar range protected from grazing the entire year.

On fenced grama-grass ranges of the Southwest where the stock are carried mainly on range feed throughout the year, light stocking during the growing season is profitable. It will probably not reduce the total animal-days' feed furnished on a given area during the year, and will reserve feed for the critical period from February to July, or later in case of prolonged drought.

Where the whole of a range unit is made up of grama or similar grass, about one-third of the area should probably be reserved for light grazing during the growing season two years in succession. Each third in turn should be given as nearly as practicable this amount of protection. By light grazing is meant grazing by not more than half the average number of stock that the area will carry for the year as a whole.

WATER DEVELOPMENT.

Fairly efficient use of plains and mesa range in the Southwest can be secured where stock do not have to travel more than 2½ miles to water. This means one watering place for each 13,200 acres. Such an acreage of grama-grass range will carry about 500 cattle throughout the year if properly managed.

As the distance in excess of 2½ miles which stock have to travel to water increases, the barren area around water increases, as does also the partly used forage beyond 2½ miles from water. Consequently the number of stock the range will support is reduced. When feed is short, a long distance between feed and water tends to increase the loss of stock, to decrease the calf crop, and to retard development of the young animals.

Observations to date appear to justify one permanent watering place for each 500 head of cattle. Where conditions are favorable, the construction of tanks to catch flood waters for the purpose of supplementing the permanent watering places will be a paying investment. They will aid (1) in getting more green feed for the stock during the year, (2) in more even utilization of the range as a whole, (3) in the protection of feed and range near permanent water, and (4) in reducing the cost of maintenance and operation of wells.

CARRYING CAPACITY.

During 1916 the Jornada Range Reserve as a whole supported one animal, not including unweaned calves, on an average of 41.45 acres. The estimated maximum carrying capacity of the Reserve in its present stage of development is 38.1 acres per head. The estimated carrying capacity of similar unfenced range in its present average condition is at least 50 acres per head.

The range on the plains, where grama grasses form the bulk of the forage, will support stock throughout the year at the average rate of one head to from 20 to 30 acres, depending upon the proportion of the real grama-grass type. This figure is for range in good condition, fairly well supplied with stock water, and which is lightly stocked during the growing season.

The range comprising tobosa-grass flats, along drainage lines, and slopes back to the foothills will support stock throughout the year at the average rate of one head to from 38 to 45 acres, depending

upon the percentage of tobosa flats which receive flood water. Such areas are of higher forage value than the average for this class of range as a whole.

The mountain range of the Jornada Range Reserve will support stock at the rate of approximately 60 acres per head in its present stage of development.

All of the foregoing estimates are on the basis of carrying the stock through average or slightly less than average years in fairly good condition. If loss from starvation is to be eliminated, a small percentage of the poor stock will have to be fed cottonseed cake or other feed to supplement range forage.

INCREASE IN CALF CROP AND IMPROVEMENT IN GRADE OF STOCK.

From 500 selected cows and 20 bulls, held in pastures away from other stock since August, 1915, an 81 per cent calf crop was branded in 1916. It is expected that this figure will probably be an average one over a period of years. From the remaining cows of breeding age, amounting to 1,522 head run together in one pasture of 74,714 acres, a 69.2 per cent calf crop was branded. The average calf crop for the Reserve was 72 per cent. It is doubtful whether the average calf crop on adjoining unfenced range in 1916 reached 60 per cent, and this figure is believed to be a high average for the calf crop on these ranges for a period of years past.

A total of approximately 50 pounds of cottonseed cake per head was fed to the 500 cows and 20 bulls of the selected breeding herd on the Reserve. The work of caring for this herd took half of one man's time. All of the bulls and perhaps 75 per cent of the cows were fed cake. To this special care and the fact that they were unmolested by other stock is attributed the large calf crop. In the herd having 1,522 head only 2 per cent of the cows and only 75 per cent of the bulls were caked. This and the fact that so many animals were run in one large brushy area, making adequate bull service difficult, are believed to be largely responsible for the difference of 11.8 per cent in the calf crop of the two herds. If so, the extra calves in the special herd far more than pay for the extra feed and labor.

The big opportunity for increasing the calf crop is to keep poor cows in thrifty condition. This can be done by not overstocking the range used by breeding stock and by feeding a small quantity of cottonseed cake or other supplemental feed to the cows that need it. Indications are that this is a good business proposition. All bulls should be fed during the winter and early spring.

By avoiding overstocking and by using supplemental feed the improvement of the average animal should pay, at least in part, for the decrease in number of stock and increase in cost of care. The

increase in the calf crop will pay for the greater part, if not all, of the increased expense. Marked improvement in average grade is noticeable among stock of the Jornada Reserve as a result of selling off about 25 per cent of the poor-grade, off-colored, and otherwise undesirable stock, and replacing them by good grade heifers.

PREVENTION OF LOSS.

The average loss of stock on the Jornada Range Reserve, June 1 to December 31, 1915, was at the rate of 1.9 per cent for a year; the average loss in 1916 was 1.5 per cent. The average losses for New Mexico are approximately 10.6 per cent for calves to 12 months of age, 5.6 per cent for yearlings, and 5.8 per cent for other stock.

The small loss at the Jornada Reserve is attributed to careful, systematic vaccination against blackleg, to the reservation of grama-grass range for poor stock during the critical spring months, to feeding the animals a small quantity of cottonseed cake, and to prevention of straying.

In order to provide for extra range for the breeding stock in poor years, one-third of the stock on a range unit should be steers. It is then possible to reduce the number of stock, when necessary, by selling steers, without great sacrifice and without interfering with the breeding stock. In good years the number of steers can be increased and in bad years decreased.

To provide against loss in extremely bad years, some kind of roughage to supplement the range forage, for feeding with cottonseed cake or other concentrated feed, would be a decided advantage on southwestern ranges. Ensilage made from soap weed (*Yucca elata*) has been tried, and the results are promising, but not extensive enough to warrant definite conclusions.

Feeding cottonseed cake to calves weaned during the late fall, winter, and early spring is an important factor in cutting down loss and increasing the size of the stock, as well as in increasing the calf crop. Where this is done, young calves can be taken from poor cows, thus reducing loss from starvation among both cows and calves and stimulating earlier breeding. Indications are that such feeding is a good business venture from the standpoint of increased value of the calves, aside from decreasing the loss from starvation.

Range feed not more than 2½ miles from water is a big factor in cutting down loss from starvation, especially where little or no supplemental feeding is done.

The possibilities of decreasing loss justify more attention on the part of stockmen to careful, systematic vaccination as a preventive of blackleg and to picking out and feeding stock in need of special care.

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